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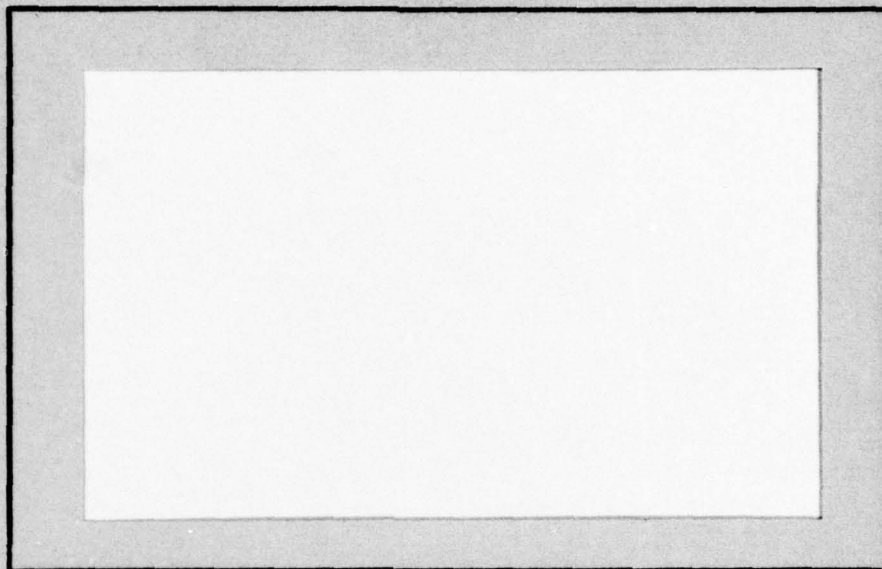
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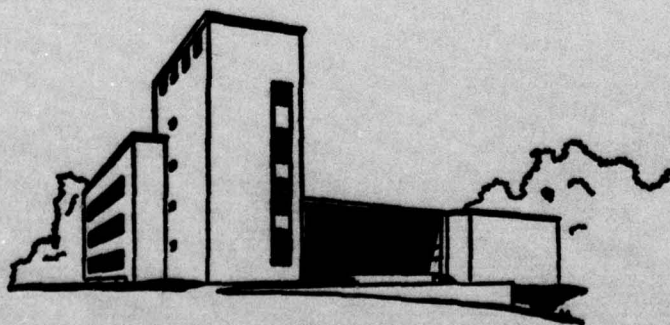
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BEHAVIORAL EFFECTS OF AUDITS IN THE DELIVERY

OF HEALTH CARE: RESULTS FROM EXPLORATORY DATA ANALYSIS

by

Neil C. Churchill
The Royal D. Little Professor of Business Administration

William W. Cooper
The Arthur Lowes Dickenson Professor of Accounting

Vijayaraghavan Govindarajan
Doctoral Candidate in Business Administration

Harvard University
Graduate School of Business Administration
Boston, Massachusetts 02163

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The "Utilization Reviews" required under the Bennett Amendment to the Social Security Act of 1972 can be interpreted as "independent audits" of the practices of medical professionals utilizing hospital services. This includes audit of the hospital by an independent Professional Standards Review Organization. Implementation of this law was phased in a way that makes it possible to distinguish between "audit anticipation" and "audit occurrence" as separate aspects of "audit per se" -- i.e., the "audit process" as distinguished from any reports flowing from it. Using data on (1) Appendicitis and (2) Primary

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Cholecystectomy from a Boston area hospital, techniques from Exploratory Data Analysis are exploited to form hypotheses about the effects of these audits. The resulting hypotheses all suggest that the Utilization Reviews had significant effects on the behavior of medical professionals with respect to length of patient stay -- which were then confirmed by subsequent statistical (confirmatory) tests of the usual (classical) variety. Openings provided for further research on the use of audits as a means for managing the behavior of such personnel as medical professionals, research scientists, etc., are briefly indicated along with other new management tools that can be provided from such research.

ABSTRACT

The "Utilization Reviews" required under the Bennett Amendment to the Social Security Act of 1972 can be interpreted as "independent audits" of the practices of medical professionals utilizing hospital services. This includes audit of patient-doctor relations by staff of an admitting hospital as well as audit of the hospital by an independent Professional Standards Review Organization. Implementation of this law was phased in a way that makes it possible to distinguish between "audit anticipation" and "audit occurrence" as separate aspects of "audit per se" -- i.e., the "audit process" as distinguished from any reports flowing from it. Using data on (1) Appendicitis and (2) Primary Cholecystectomy from a Boston area hospital, techniques from Exploratory Data Analysis are exploited to form hypotheses about the effects of these audits. The resulting hypotheses all suggest that the Utilization Reviews had significant effects on the behavior of medical professionals with respect to length of patient stay -- which were then confirmed by subsequent statistical (confirmatory) tests of the usual (classical) variety. Openings provided for further research on the use of audits as a means for managing the behavior of such personnel as medical professionals, research scientists, etc., are briefly indicated along with other new management tools that can be provided from such research.

— A —

KEY WORDS

Utilization Reviews

Independent Audits

Professional Standards Review Organizations

Hospital Management

Physician Behavior

Length of Patient Stay

Audit Anticipation

Statistical Tests

Econometric Models

Exploratory Data Analysis

Field Studies

Quasi Experimental Designs

Behavioral Auditing

Types of Audits

This article will explore the potential value of audits as a tool for management and/or social control to guide the behavior of medical professionals in a hospital administration context. Control, direction and even influencing the behavior of such professionals may be thought of as only one of many areas which have provided a variety of sometimes baffling challenges to more customary management approaches -- such as direct supervision, etc. -- if only because of the knowledge discrepancies of managers. For instance, in addition to medical professionals (e.g., surgeons) in hospitals, one may cite the activities of scientists participating in a program of advanced research or even the activities of academics in institutions of higher learnings. Ambiguities in locating and stating objectives for the latter, however, make it seem advisable to direct attention to the behavior of medical professionals. Here these ambiguities are less intense, e.g., in their bearing on patient treatment, etc., and then, of course, what is learned about audit effects here relative to these objectives may provide a basis for extension to some of the other areas noted above.

The term "audit" is intended here to refer to an independent process of review and appraisal that carries with it a third-party orientation (e.g., as embodied in an audit report) along with criteria of objectivity and competence that makes it possible to appraise the audit process itself as well as the activities that are audited. It is not intended to confine the term "audit" to the usual CPA attest audit although, to be sure, that

kind of audit fits within the description we have just provided. We use the term rather in the sense of "comprehensive audit" which, as we have elsewhere noted,[1] does not confine an auditor to examination of financial statements prepared by others. Instead, it opens all aspects of management (and other) behavior for such examination and assigns the audit or responsibility for choosing the area of audit which is supposed to be done by reference to the 3rd-party relations that are thereby to be serviced.[2]

In comprehensive audits, the choices of the 3rd-party relations to be serviced and the way they are to be serviced is also a responsibility of the auditor. Note, however, that this servicing need not involve a formal report. Indeed, for purposes of this study, we follow Churchill [1962] and distinguish between "audit per se" and the "audit report." The latter is further distinguished by reference to the "audit findings" and "audit recommendations" that it may contain, but audit per se refers to the audit process (i.e., the scope and method of audit conduct) whether or not a report issues from it.

We also follow Churchill [1962] and further distinguish between the "occurrence of an audit" and the "anticipation of an audit," which may each have behavioral consequences in their own right. Quite clearly, no

[1] See N. C. Churchill, W. W. Cooper, V. Govindarajan, J. D. Pond, and J. G. San Miguel [1977].

[2] For further discussion of this servicing of 3rd-party relations, see W. W. Cooper and Y. Ijiri "Accounting and Accountability Relations" in Eric Louis Kohler -- Accounting's Man of Principles (Reston Publishing Co., forthcoming). For a discussion of its relation to accounting, see the exchange between A. Thomas, Mildred Francis and V. Govindarajan and J. Pond in "Evaluation of Social Programs: Some thoughts on the Role of Accountants," The Accounting Journal, Vol. 1, No. 2 (1978).

report is involved in audit anticipation, at least in the sense of specific

audit findings and/or recommendations. Indeed, explicitly specified

audit criteria are also not present. Even a clear delineation of

the actions to be examined need not be present unless some pre-

arranged specification of procedures to be followed or the reports to be

rendered   are   sufficiently associated with the possible

use of an audit. [1]

Audits and Utilization Reviews

For purposes of this study, in any case, the 3rd-party

orientation is assumed to be present, but with possible different

behavioral effects, in both audit anticipation and audit occurrence.

To test hypothesized behavioral effects of both of these aspects of

auditing, recourse was had to data on the possible effects of "Utiliza

tion Reviews" both in anticipation and occurrence in a not-for-

profit teaching hospital in the Boston area. Hence we need to say

something about the nature of these Utilization Reviews, including

their sources and authority, and the audit processes to which they

relate.

First we observe that the Bennett Amendment to the Social Security

Act, from which the authority stems for these audits, was passed in October 30, 1972.

As observed in the appendix, this amendment provided for a PSRO (Professional

Standard Review Organization) in each region with independent authority

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[1] This is the point of view that is taken in the present study where
such developments of record-keeping and reporting practices are all
regarded as flowing from the audits being utilized.

for establishing standards and responsibility for monitoring (i.e., externally auditing) the Utilization Reviews and related audit activities in each subject hospital. A grace period until April 1975, contained in this Amendment, made it possible to study the effects of these audits (= Utilization Reviews + PSRO monitoring) in their actual occurrence as well as the related audit anticipations by reference to data collected for each of the following 3 periods of time:

Prior to 1972: no concurrent audit and no anticipation of Utilization Reviews

Nov. 1972 and March 1975: no audit occurrence but anticipation of concurrent Utilization Reviews

April 1975 - present: concurrent Utilization Reviews by the hospital staff plus external monitoring by the local PSRO

This provided a "quasi experimental" setting in the sense of Campbell and Stanley [1963] which was utilized to analyze the effects of "audit anticipation" and "audit occurrence" on the length of stay.

Inter alia these Utilization Reviews provide a control over attending physicians by reference to criteria established by the PSRO with respect to type and number of diagnoses as well as demographic and other characteristics that bear on the nature of the medical treatment. These criteria are intended for application to issues like the

following:

    i. Did the patient receive the proper medical treatment?

    ii. Was the patient assigned to the correct facility (e.g., was assignment to an intensive care unit justified)? and

    iii. Was the length of hospital stay excessive or deficient?

Here we shall focus on the last issue by reference to "concurrent utilization reviews."[1]

There are a variety of control procedures with related possibilities that the attending physician has for appeal when he disagrees with the resulting decisions for such items as "length of stay" for any particular patient.[2] Here, however, we shall simply regard these as part of the behavioral consequences of the audit process we are studying and lump them all together for this purpose. The important points for our study are (a) these procedures do flow from and are re-enforced by the audit process and (b) the resulting processes have the requisite property of providing a basis for appraisal of the medical professional's judgements. Together with the PSRO

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[1] Concurrent Utilization Reviews are conducted while the patient is still in the hospital, as distinguished from "Post-Discharge Utilization Reviews" which are conducted after a patient has left the hospital.

[2] These are described and discussed in Govindarajan [1978].

(external audit) monitoring, they also provide the key ingredients of independence and the third-party orientations that we earlier identified with audits. Here the third-party orientation takes the form of a peer review provided by other medical professionals -- as well as others -- both internally in the hospital and in the PSRO. It is also of interest to observe that it is relatively rare for the results of these audits to be reported back to the attending physician in the form of a report of patterns of findings and/or recommendations. That is, apart from the control process that is applicable to each case, there is no audit report which identifies entire patterns of behavior even for individual physicians as a basis for findings and/or recommendations. Nevertheless, as we shall see, both audit occurrence, in the form of audit per se, and audit anticipation ha e significant effects on patient length of stay.

Case-Mix and Type of Variables

One of the problems encountered in some of the earlier studies (e.g., Lave and Leinhardt [1976]), which arrived at conclusions that differ from ours, is that they made before/after comparisons for the effects of Utilization Reviews with respect only to the average length of stay over all diagnoses. Since different diagnoses with varying degrees of complications generally require different lengths of hospital stay, such aggregate comparisons could be quite misleading, especially if the case-mix varies as it is likely to do from one time period to another and even from one hospital to another. One

way of eliminating changes in case mix is to examine the length of stay for each diagnosis separately. We have made such separate comparisons for two diagnoses, and, in addition, conducted extensive field checks by reference to interviews (and other data) with knowledgable medical professionals not only in the instant hospital but in others as well.[1]

Acute appendicitis and primary cholecystectomy were chosen for this purpose. These two diagnoses have the following characteristics which bear on our analyses and conclusions:

(a) These two are among the most frequently treated diagnoses in the hospital. They therefore provide a rich data base to work with.

(b) Patients admitted for these two diagnoses do not develop complications very frequently. Since such complications not only increase the length of patient stay but also require more involved analysis, we would like to be able to deal with them separately, without thereby greatly diminishing or otherwise weakening our data base.

(c) There have been no substantial technological advances in the selected diagnoses during the study period and, further, the technological

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[1] See V. Govindarajan [1978] for the results of these interviews.

advancements are easily traceable. This helps
to control for the influence of varying medical
technology on the length of stay.

Data Collection: For both diagnoses, data were collected for each
individual treatment on the following variables during a nine-year
period from July 1968 to March 1977:

1. Code number of the attending physician.

2. Code number of the attending surgeon.

3. Complications in treatment.

4. Age of the patient.

5. Sex of the patient.

6. Month in which patient was admitted to the hospital.

7. Total length of stay of the patient.

Exploratory and Confirmatory Data Analyses

The data were first analyzed using certain new statistical
techniques, called "Exploratory Data Analysis," EDA, which emphasize
(a) robustness and (b) detection and analysis of outliers [Tukey,
(1977)]. In EDA, the emphasis is on median and median-related tech-
niques which are very little affected by stray values. That is, the
emphasis is on "robustness" and the identification of "outliers."
This contrasts with more customary statistical analyses,
and inference procedures, SAI, which emphasize "sensitivity" and "central
tendency."

There is no necessary conflict between SAI -- with its
emphasis on significance tests, etc. -- and EDA, with its emphasis on

separation of outlier and nonoutlier information and the detection of patterns in each. Indeed the two may be used in sequences in a very natural strategy wherein, at one stage, EDA is used for hypothesis development and, at another stage, the well-known procedures of SAI are employed to test these hypotheses, effect estimates and determine quantitative relations which may be used to effect interpolations and extrapolations from the original data set.

Because EDA is at present relatively new (and still in its early stages), we shall emphasize its use in the discussion that follows. Suffice it to say here, therefore, that the resulting hypotheses have now been confirmed at the 1% level of significance or better in almost all cases, and have also been successfully submitted to other tests, too, both singly and in combinations.[1]

Before proceeding to these explanations, however, we should summarize the results of our study to date as follows:

1. The evidence indicates that both audit anticipation and audit occurrence have pronounced effects in the form of reduced length of stay. The magnitude of audit occurrence is significantly greater than the magnitude of audit anticipation.

2. These reduced length of stay phenomena appear in both outlier and nonoutlier data.

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[1] E.g., via customary least squares regressions to control and allow for the separate and combined effect of variables other than audit anticipation and occurrence on length of stay.

3. The nonoutlier data show reduced scatter
    (i.e., increased homogeneity) while the
    outlier data do not over the indicated
    study interval.

The above summary is rough and subject to qualifications (which we
shall enter later) with respect to parts of the study that are still
under way. Nevertheless, this summary will help in focussing atten-
tion during the discussion that follows on the use of EDA as one stage
of a total process en route to these results. Finally, we should observe
that these study results, which involve both EDA and SAI, have produced a
variety of new tools such as regressions (which are also significant sta-
tistically), and which can be used to improve the processes of
hospital management. This, too, could be counted as a further con-
sequence of the audit/Utilization Review process in case these tools
should be adopted by this hospital.

Major Findings: Aggregate Audit Effects

Before proceeding to analyze the audit effects at the aggregate hospital
level, we first attempted to identify exogenous factors unrelated to the Utilization Re-
views that might influence patients' stay in the hospital. This could then help us to iso-
late the influence of these exogenous factors and direct our examination of length of stay
for possible audit effects remaining after allowing for these other factors.

Impact of Occupancy Rates: Occupancy rate* which is an indication
of capacity utilization has an important influence on the patients' length
of stay in hospitals. If the occupancy rate in a hospital is very high, say

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*

Occupany rate = $\dfrac{\text{Number of in-patients receiving care on an average day/year (excluding newborns)}}{\text{Average number of beds per day regularly maintained for in-patients during a year}}$

close to 100%, then doctors might be under pressure to discharge their patients due to shortages of beds which, in turn, tends to shorten the average length of hospital day. To examine whether such effects might be present we collected data on the occupancy rates in the hospital weh have chosen over the last five years* which we report as follows:**

	'72	'73	'74	'75	'76	'77
Occupancy Rate	79.2%	78.6%	81.2%	77.5%	78.3%	75.6%
Patient Days	83,462	87,291	94,173	95,918	97,142	93,514

The occupancy rates in the last 5 years have been below 80% and further the occupancy rate is steadily falling over the 5 year period. These observations indicate that there is still slack in the availability of hospital beds, i.e., the doctors are not under pressure to discharge their patients due to shortage of hospital beds. Thus it is not plausible to attribute reductions, if any, in the average length of hospital stay in our hospital to pressure emanating from high and/or rising occupancy rates.

Impact of Age, Sex and Complications in Treatment: Exhibit 1 gives what is called in EDA a stem-and-leaf display of the length of stay on all the 778 patients treated for acute appendicitis during 1968-77. In the display included in Exhibit 1 each of the digits 2 to 11 on the left of the veritcal line is a stem, and

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*Strictly speaking, since we are dealing with acute appendicitis, an examination of the hospital-wide occupancy rates is appropriate only if beds are perfectly substitutable among different departments. The difference appears moot, however, since, informal discussions with hospital officials revealed that slack bed capacity exists even in the departement which handles the two diagnoses we have chosen for study.

**Total patient days in 1974 took a sharp increase due to 21 new beds added in psychiatry in December 1973. These 21 beds had an occupancy rate of 92% during 1974.

each remaining digit placed to the right of the vertical line is part of a
leaf (in our case, these are all equal to zero).

The display in Exhibit 1 can be understood better by
comparing it to the familiar histogram which is constructed using
class intervals. Each stem in the above display has a class interval
of 1 day. The leafs corresponding to each stem give the number of
data values in that stem. This idea is similar to a histogram where
the length of each bar is proportional to the number of data values
in that interval (often called "frequency"). However, a stem-and-leaf
display has an advantage over a histogram, in that the former gives
numerical detail in their leaves whereas the length of each bar in a
histogram is either a blank or a shaded space as if all data were
"centered" in each class interval.* Note that it is therefore pos-
sible to go back from what appears in a stem-and-leaf display to the
full "raw" data values.

One advantage of the stem-and-leaf display as an aid to hypo-
thesis formulation -- for subsequent confirmatory statistical analyses --
is that it helps (or even forces) us to see both the regularities and
irregularities in a batch of data values. For instance, we can see
from Exhibit 1 that most patients had stayed between 4 and 8 days.

At this stage, however, we were particularly interested in iden-
tifying possible "outliers" in the patient days data, so that we could
give them special attention. For this purpose, we computed a "five number
summary" for the data and the results are as follows:

---

*
This contrast could be brought out more sharply if our data had permitted
us to regard "fractions of a day" in place of the 0's (whole day units)
in our leafs.

2 (4, 5, 7) 119*

where 2 = Extreme Value (Lowest)

4 = Hinge (Lower)

5 = Median

7 = Hinge (Upper)

119 = Extreme Value (Highest)

Here we have again used the terminology of Exploratory Data Analysis. These 5 values, it may be observed are for variables which are approximations to well known statistical concepts. For instance, the "First Quarter" and "Third Quarter" are the same as the corresponding "quartiles" in which we, following Tukey, replace the latter terms with the former in the interest of simplicity of expression. In the classical literature, the difference between the maximum and minimum values gives the "range," = 119 - 2, and the difference between the third quartile and the first quartile gives the "interquartile range." Tukey refers to the difference between the lower and upper hinges as the Q-spread = 7 - 4, again to provide an easiness in expression but which again is an approximation to the classical interquartile range.

The above summary gives several useful insights into a batch of data We can get a feel for the <u>extreme</u> values (in our case, the lowest and highest values are 2 days and 119 days, respectively) as well as the most typical value in the batch (in our case, the median is 5 days). Further, the <u>Q-spread</u> gives us a useful indication of a middle amount of spread for the batch (in our case, the Q-spread is $7-4 = 3$ days). Note that unlike the variance or standard deviation, the Q-spread does not depend on underlying assumptions of symmetry for its interpretations. Indeed, the Q-spread can help us to identify properties such as skewness in the data when we relate it to other measures such as the median, and this is what we want at this stage of an analysis.

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*The <u>depth</u> of a data value is the number of data values one must count in from the nearer end of the batch in order to reach the particular data value. Each extreme value -- the lowest and the highest -- is at depth 1. The median is at depth (1 + total number of observations)/2 , i.e., median can be found by counting half-way from one extreme to the other. The two hinges -- upper and lower -- can be found by counting half-way from each extreme to the median, i.e., the depth of each hinge is $\frac{1 + (\text{depth of median})}{2}$

The notion of Q-spread can further help us detect stray values or outliers. Tukey's rule for detecting outliers is based on these definitions:

<u>Step</u> : 1.5 x Q-spread

<u>Fence</u> : 1 step outside each hinge

A value <u>beyond</u> the (upper or lower) fence is tagged as an outlier.

Using this rule, we identified the 38 outlier values indicated at the bottom of Exhibit 1. We then proceeded to examine these 38 cases individually to see whether they had any characteristics that distinguished them from the rest of the 740 cases. Out of the 38 cases, (a) 27 were associated with medical or surgical complications or both and/or (b) they represented patients who were older, i.e., above 65 years of age. We therefore have information which indicates that medical and surgical complications are present that entail a longer treatment for these cases. Also older patients tend to develop complications and hence would require a longer hospital stay.

We proceeded to study this further. The correlation matrix given in Exhibit 2 also suggests the already indicated relationship between medical and surgical complications, on the one hand, and length of stay, on the other (correlations of 0.5092 and 0.3903, respectively). See also the intercorrelation between Secondary Diagnosis and Secondary Surgery, which is 0.4731. Similarly, age appears to have a relatively high relationship with medical complications (correlation of 0.3028) and in turn, with hospital length of stay (correlation of 0.3224).

To explore these ideas still further, we cross-tabulated (using medians) the length of stay with different types of complications, different age group of patients and sex classifications. The results of these cross-tabulations are given in the following Exhibits:

Cross-Tabulations Using Medians

Exhibit No.	Dependent Variable	Independent Variable(s)
3a	Length of stay	Secondary Diagnosis
3b	"	Secondary Surgery
3c	"	Sex
3d	"	Age
3e	"	Secondary Diagnosis and Secondary Surgery
3f	"	Secondary Diagnosis, Secondary Surgery, and Age

The following points, based on an analysis of the above Exhibits, can be highlighted:

(1) Medical and surgical complications do have an important effect on the patients' hospital stay. That is, as we proceed from no complications ("0" level) to more complicated treatments ("1", "2", "3", etc. levels), median length of stay increases appreciably (Exhibits 3a and 3b).

(2) Sex has no effect on hospital stay since both males and females have an identical median length of stay of 5 days (Exhibit 3c). This is expected since acute appendicitis is not supposed to result in longer lengths of stay for males as opposed to females or vice versa.

(3) The age of the patient has a strong influence on the length of stay. The median length of stay for patients who are 65 years or younger is 5 days whereas patients who are older than 65 years have a median length of stay of 12 days (Exhibit 3d).

(4) The two-way and three-way cross-tabulations given in Exhibits 3e and 3f also point up to the same conclusions mentioned in (1) and (3) above.

Note that we have used a robust (distribution free) statistic in the form of the median rather than the more sensitive mean (which is not distribution free) so that the above differences indicate the presence of strong underlying causal relations for the indicated variations. In any case our analysis so far has shown that only the hospital stay of 663 patients, i.e., patients who have no complications and whose age is 65 years or less, need to be examined to identify possible "normal" (i.e., non-outlier) effects of Concurrent Utilization Reviews.

Impact of Long-Term Trend: Of course, the static analysis such as we have now conducted does not cover other things that also need to be considered. Issues of trend need to be considered and also variations about measures of central tendency both statically and over periods of time.

Exhibit 4 presents a plot of the mean length of stay over 105 months. This plot indicates a tendency for the length of stay to go down as we proceed in time, and we are interested in finding out how much of this decrease can be attributed solely to a long-term downward trend in the length of stay. It is possible that a gradual improvement in the health standards of the population over the years might contribute to a gradual lowering of the length of stay since the initial medical condition of a patient does influence the patient's stay in the hospital. Also,

technological advances could have brought down the length of stay over time.*

Our interest here was to identify the long-term trend, if any, in the particular diagnosis we have chosen for study, i.e., acute appendicitis. Thus we confine ourselves to this diagnosis and turn to the first of these possibilities in order to ascertain whether an identifiable time trend is present in the data. For this purpose we utilized the data over 51 months from July 1968 to October 1972** to estimate the following equation using the technique of robust regression:

$$\hat{Y}_i = \hat{\alpha} + \hat{\beta} \, T_i \quad \dotfill (1)$$

where $\hat{Y}_i$ = Length of stay in the ith month

T_i = Linear time variable (monthly)***

The numerical results are as follows:

$$\hat{Y}_i = 7.000 - 0.000000003725 \, T_i$$

Average sum of the absolute residuals = 1.534

In the above estimates, we notice hardly any trend in the data since the Beta coefficient corresponding to the time variable is almost zero.#

---

*Recall that we earlier eliminated pressure on bed space as a possible source of this trend.

**We considered this period since there was no Concurrent Utilization Reviews during this period and therefore, no confounding influences due to audit anticipation or audit occurrence will be present.

***Since we have no a priori information pointing otherwise, we fitted a linear trend line.

#This is not statistically significant but even if it were statistically significant the coefficient is so small that it could not be accorded either administrative or economic significance. Note, however, that any ordinary (least squares) regression is with respect to the mean whereas the robust regression is formed relative to the median, a much less sensitive statistic. Thus a least squares (ordinary) regression might have given a different result than the former.

We had estimated the trend using data over a fairly long period of 51 months and could find <u>no</u> evidence to support the presence of any long-term trend for this particular diagnosis. It should perhaps be pointed out here that since our emphasis is on <u>Exploratory</u> Data Analysis, isolating the exogenous factors one at a time, is justified as we have done.

We further discussed our data analyses with a few surgeons in the instant and other hospitals. The interviewees also could not point up any possible influence of long-term trend including technological advances on the length of stay for acute appendicitis. Thus we provisionally rule out such trend possibilities and turn to other factors.

Analysis for Aggregate Audit Effects

First, we divide our time periods in a different way than before in order to examine the possible effects of audit anticipation and audit occurrence on the length of stay. We will do so by separating out noise insofar as we can identify it now, by, for instance, considering only the data for the 663 patients of age 65 or less who had no complications.

We divide the 663 cases identified earlier in the following manner: (a) 310 were treated during July 1968-October 1972 when there was neither occurrence of Concurrent Utilization Reviews nor any plausible basis to believe that anticipation was present that such reviews will occur (to be referred to as "no audit" period); (b) 220 patients were treated during November 1972-March 1975 when it is plausible to believe there was anticipation that such reviews would occur (to be referred to as "audit anticipation" period), and (c) 133 patients were treated during April 1975-March 1977 when there was actual occurrence of such reviews (to be referred to as "actual audit" period). It appears from the plot in Exhibit 4 that the <u>median</u> length of stay during the "audit anticipation and "actual audit" periods are lower as compared to the "no audit" period.

More importantly, the "no-audit" period exhibits more <u>variance</u> than the other two periods.

To further examine the audit effects, we prepared stem-and-leaf displays of the length of stay during the three periods (Exhibits 5a, 5b, and 5c). It can be seen from these Exhibits that length of hospitalization is clustered around 6 days for the no audit period, 5 days for the audit anticipation period, and 4 days for the actual audit period. This can also be seen by examining the medians in the following 5-number summaries:

No Audit Period   :   2 (5, <u>6 (Median)</u>, 8) 18

Actual Anticipation Period :   2 (4, <u>5 (Median)</u>, 6) 17

Actual Audit Period   :   2 (4, <u>4 (Median)</u>, 5) 14

It seems evident from the following figures that <u>both</u> the <u>median</u> hospital stay as well as the <u>spread</u> around the median <u>decline</u> as we proceed from (a) no audit to (b) audit anticipation to (c) actual audit:

	Median Length of Stay	Q-Spread
No Audit Period	6 days	3 days
Audit Anticipation Period	5 "	2 "
Actual Audit Period	4 "	1 "

Reverting to another technique of Exploratory Data Analyses we can bring out the audit effects indicated above more dramatically   by means of the "box plot." for the length of stay for these three periods which is displayed in Exhibit 6. We proceed to explain what is involved as follows: We can illustrate the technique of constructing such a plot by examining the anatomy of the following schematic plot (similar to the plot in Exhibit 6) which, as we can see, is based on an augmentation of the 5-number summary idea discussed earlier.
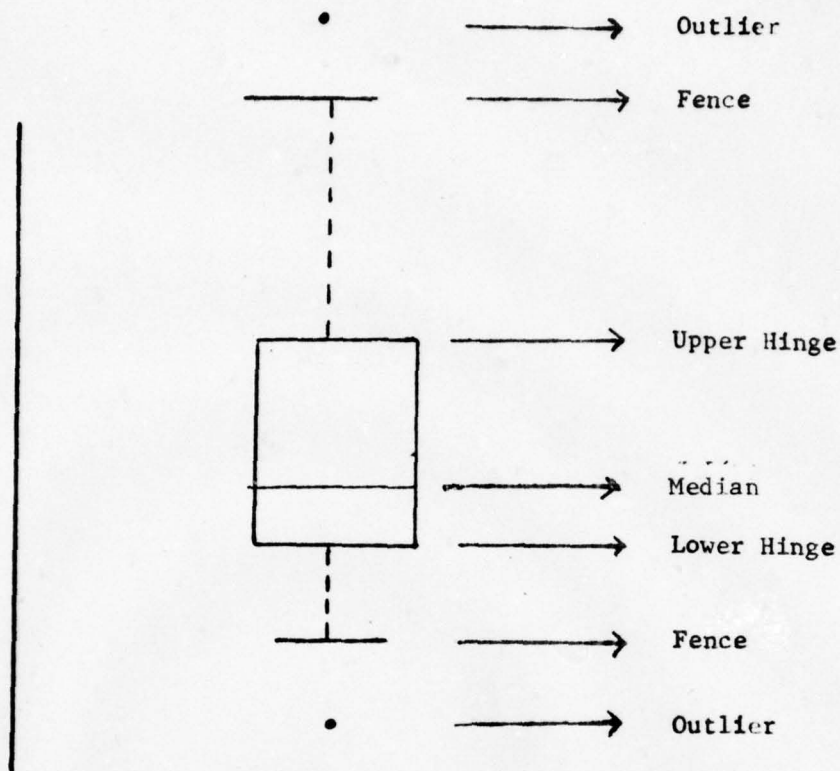
Such a plot provides a schema that is designed to provide a simple-to constuct, but effective, visual technique for comparing related batches of data or, rather, data summaries. By constructing such schematic plots for several batches side by side, we can gain insights by reference, e.g., to (a) the level of the median in the various batches, (b) the amount of spread in each batch, and (c) the number and value of outliers in each batch.

Analysis of non-outliers: From Exhibit 6 we note that the median value of the length of day and its spread decrease as we proceed from no audit anticipation to actual audit period.

Analysis of Outliers: We next identified the outliers for the three periods which are as follows:

-21-

<u>Outliers</u> (in days)

No Audit Period	:	13, 13, 14, 15, 18
Audit Anticipation Period:		10, 12, 12, 13, 17, 17
Actual Audit Period	:	7, 7, 7, 7, 8, 8, 8, 9, 10, 14

A separate analysis of the outliers indicated above shows two patterns: (a) there is some downward trend in the <u>size</u> -- not only in median but also in the maximum value -- of the outliers over the three periods. This may indicate that audit in its occurrence is likely to discourage too much deviation from the audit criteria. (b) The scatter varies, however, and in fact there is an <u>increasing</u> scatter in the outliers over the three periods. This may indicate more discriminatory treatment during the audit period as compared to the pre-audit period. These two patterns are also visible in the dots at the top of the box plot given in Exhibit 6.

<u>Results for Primary Cholecystectomy</u>: Having developed our results for acute appendicitis in some detail we can condense our discussion for the affects of Utilization Review in the case of Primary Cholecystectomy. We might note, however, that similar audit effects were noticed for primary cholecystectomy based on our study which we summarize as follows:

We analyzed 416 uncomplicated cases of primary cholecystectomy and observed the following results:

	Mean Length of Stay	Q-spread
No Audit Period	11 days	5
Audit Anticipation Period	9 days	3
Actual Audit Period	8 days	2

This reduction in the median and its spread is brought out in the box plot given in Exhibit 7.

In summary, we notice the following audit effects for both diagnoses:

(1)   For the bulk of the observations, audits -- both anticipation and actual occurrence -- tend to bring down the average length of stay and its variance.

(2) In the case of outliers, audits tend to decrease the size of
outliers but increase variability in the measures of scatter
around the average length of stay.

Thus, we can say in an overall way that audit effects were uniformly detected in the hypothesized directions with actual audit consistently having a significantly stronger effect than audit anticipation.

Major Findings: Individual Surgeon Level

So far we have analyzed audit effects only at the aggregate hospital level. We will now focus on the indiviudal surgeons to see whether we can observe similar results at the individual surgeon level. Inter alia this will help us to deal with issues such as possible changes in the mix and practices of the surgical staff.

Analysis by Surgeons: Here we shall only consider doctors who have treated 20 or more cases for the two diagnoses during the 9 year period from July 1968 to March 1977. Such a list of doctors is contained in Exhibits 8 and 9. Given this list we then proceeded to make before/after comparisons of the median length of stay and the spread around the median for each of the doctors identified in Exhibits 8 and 9. The results are attached as Exhibits 10 and 11 which we summarize as follows:

(1) For both diagnoses, audits -- both anticipation and actual occurrences -- produced effects in desired directions for the majority of surgeons.

(2) Even though most of these surgeons responded favorably to audits, there were differences in that (a) the audit effects were greater in the case of some surgeons than others and (b) in some few cases the results seemed reversed. See the surgeons coded as numbers (Exhibition 10) and 10 (Exnibition 11).

Implications

We will now consider some of the major implications of our results on practice. Hospital administrators, who usually have only a management background can experience problems in terms of comprehending and controlling the activities of surgeons and other medical practitioners subject to their management authority. New tools of management seem to be called for and audits seem to offer one such possiblity. This study has helped to confirm the potential value of audits for these purposes.

These, we may observe, are peer group audits. Although they depart from CPA attest audits of management financial reports in various way, they never-theless have the requisite properties of independent review and criteria of objec-tivity and validity to provide a basis of evaluation for the audit process itself.

In our study, we focussed on "audit anticipation" and "audit occur-rence" as parts of "audit per se." These, too, could be taken into account in a suitable arranged strategy ranging from audit announcemnet through audit per se to audit report in controlling such "difficult-to-manage" areas such as the ones pre-sent in hospitals.

Even though we focussed on Utilization Reviews, our results should have implications for other types of audits in hospitals (e.g., tissue culture reviews) which evaluate quality of patient care. Indeed, as noted in the opening paragraph of this paper, further esearch directed to other difficult to manage areas such as the administration of research programs, etc. seems indicated. More generally our results also indicate new possibilities for internal audit as a tool of management in private and public sector organizations as well as using external audit for the evaluation of such organizations. Strategies based on mixes of audit anticipation and actual audit might then be used to conserve audit resources and improve managerial behavior as a result of research in these areas, too.

APPENDIX A
RESTATEMENT OF THE BENNETT AMENDMENT (P.L.92-603)

The purpose of P.L.92-603 is to promote the effective, efficient, and economical delivery of Medicare and Medicaid health services through the application of professional standards review procedures. The provision is designed to assure proper utilization of care and services through a formal professional mechanism representing the broadest possible cross-section of practicing physicians in an area. The review would assure, within recognized professional health care standards, that medical services financed under the Social Security Act are:

- Of appropriate quality,

- Provided only when necessary, and

- Provided in the most economical fashion.

Professional Standards Review Organizations

The Secretary will establish appropriate areas throughout the country by January 1, 1974, and at the earliest practicable date, designate a qualified organization as the PSRO for each area.

A qualified organization will be a nonprofit professional association, with voluntary membership, including a substantial number of the practicing physicians in the area (generally stated at 300 or more). Membership in the PSRO and service for the PSRO cannot be constrained by a requirement for membership in or payment of dues to a medical society. The qualified organization must demonstrate its professional competence to review health care services in a formal plan submitted to the Secretary.

Until January 1, 1976, the Secretary will be able to make such agreements only with a qualified organization which represents a substantial proportion of the physicians in the geographical area designated. Until January 1, 1976, at the request of 10 percent or more of the practicing physicians in a geographical area designated by the Secretary, the Secretary will be required to poll the practicing physicians in the area as to whether or not an organization of physicians which has requested to conclude an agreement with the Secretary to establish a PSRO substantially represents the practicing physicians in that area. If more than 50 percent of the practicing physicians in the area responding to the poll indicate that the organization does not substantially represent the practicing physicians in the area, the Secretary will not enter into an agreement with that organization.

After January 1, 1976, in any area where such a professional organization is unwilling or unable to meet these conditions, the Secretary may designate any public, nonprofit private, or other agency or organization as the PSRO providing that:

- The final determinations of peer review are made by physicians, and

- That the agreement will not be renewed if a qualified professional organization is willing and able to become the PSRO for the area.

Each PSRO will review the utilization and quality of all institutionally provided services in the designated area. The PSRO will not be involved with the determination of reasonable charges. With the concurrence of the Secretary, the PSRO may also review other than institutional services. These reviews will determine that:

- The services and items are or were medically necessary,

- The quality of the services meet professionally recognized standards of health care, and

- The services are or were provided at the most economical level of care appropriate to the need (i.e., outpatient, extended care, hospital, etc.).

To accomplish these purposes, the PSRO will utilize and apply regional norms of care and treatment, based upon typical patterns of practice in the region, prepared and revised by the National Council. Norms will be developed in accordance with the regulations of the Secretary and will include:

- The type and extent of service within the range of appropriate treatment for each illness or health condition, and

- The type of health care facility which can most economically provide appropriate medical services for each illness or health condition.

Each PSRO will utilize the norms described above as the standards for evaluation and will perform the following functions:

(1) Prospective determination of the medical necessity and appropriateness for elective admissions and extended or costly courses of treatment.

(2) Periodic determination and publication of selected types and kinds of cases (by service, diagnosis, or other criteria) for intensive and more effective review.

(3) Regular review of profiles of care for selected patient groups, practitioners, and other providers of service.

(4) Time specification for the certification of continuing inpatient care not later than the regional norm for the 50th percentile of length of stay for patients in similar age groups with similar diagnoses.

(5) Require physician certification, and supporting justification for continued inpatient care beyond these specified points in time.

(6) Foster the acceptance of PSRO functions by broad physician participation, rotating membership on review committees, wide specialty representation, and publication of PSRO activities in appropriate professional publication.

(7) Report any violations of the obligations of a practitioner, hospital, or other health care facility, agency, or organization, under this Program, to the State Council including any pertinent recommendations.

(8) Notify any practitioner or provider, and provide opportunity for discussion and review, when any determination denies a request for services or identifies a violation of any obligation by the practitioners or provider.

(9) Notify the pertinent intermediary of any disapproved services or items.

Physicians assigned the responsibility for hospital review should have hospital privileges in at least one of the participating hospitals in the area and should not be responsible for, but may participate in, the review of services in their own hospital. No physician will review services in which he was directly or indirectly involved or services provided by any institution, organization, or agency in which he or his family have a vested interest.

After notification, any beneficiary or recipient who is dissatisfied with a decision made with regard to his claim, will be entitled to a reconsideration by the PSRO. This decision may be appealed to the State Council, if the determination involves more than $100. Where the decision of the State Council is adverse, or in the absence of a State Council, a beneficiary will be entitled to a hearing by the Secretary in any controversy involving more than $100 and to judicial review of the Secretary's decision if the controversy involves more than $1,000.

After notification of an adverse decision by the PSRO, a practitioner or provider will have an opportunity for further discussion and review by the PSRO. The final recommendations of the PSRO are referred to the State Council and then to the Secretary who may apply authorized sanctions. Any provider who is dissatisfied with an adverse decision made by the Secretary, involving exclusion from the Program or requiring repayment, is entitled to a hearing by the Secretary and to judicial review of the Secretary's final decision.

State Councils

In any State with three or more PSRO's, the Secretary will establish and appoint the membership of a State Council which will include:

- One representative designated by each PSRO.

- Four physicians (two designated by the State medical society and two designated by the State hospital association).

- Four knowledgeable public representatives (two recommended by the Governor of the State).

Each State Council, and the PSRO's in states without a Council, will have an Advisory Group of seven to eleven members including representatives of health care practitioners, other than physicians, and hospitals and other facilities which provide Medicare and Medicaid services in the State. The Secretary will provide regulations to determine the manner in which the Advisory Group is selected.

The State Councils, where established, will:

- Review, comment upon, and transmit to the Secretary any reports, received from the PSRO's concerning violations of the Program.

- Review any appeals to a PSRO decision involving more than $100.

- Coordinate the activities of, and disseminate information and data among, the various PSRO's in the State.

- Assist the Secretary in developing uniform data gathering procedures to insure efficiency and objective comparison.

- Assist the Secretary in the evaluation of each PSRO.

- Assist the Secretary in developing and arranging for a qualified PSRO replacement, when necessary.

National Council

A National Professional Standards Review Council of eleven physicians will be appointed by the Secretary for three year terms, with eligibility for reappointment. The Secretary will designate one of the members to serve as Chairman. A majority of the Council will be recommended by national organizations representing physicians, but the Council will include physicians recommended by consumer groups and other health care interests. All members will be physicians of recognized standing and distinction in the appraisal of medical practice.

The National Professional Standards Review Council will:

- Advise and assist the Secretary in the administration of the program.

- Prepare and distribute regional "norms," with periodic revisions, based on a review of appropriate and adequate data.

- Provide technical assistance in the utilization of such norms of care and treatment.

- Review the comparative performance and effectiveness of State Council's and PSRO's.

- Recommend measures to improve the Program.

- Submit an annual report to the Secretary and to the Congress.

Authorizations to Strengthen the PSRO

To the extent necessary or appropriate for the proper performance of its duties and functions, the PSRO serving any area is authorized, in accordance with regulations prescribed by the Secretary, to:

(1) Make arrangements to utilize the services of practitioners or specialists to conduct the necessary review.

(2) Undertake professional inquiry before or after, or both before and after, the provision of any service.

(3) Examine the pertinent records of any practitioner or provider.

(4) Inspect the physical facilities in which care is rendered.

(5) Utilize the services, and accept the findings of area hospital review committees with demonstrated competence.

(6) Utilize the services of medical societies and similar organizations to assist in one or more of the review activities, when they have demonstrated their capacity to effectively perform these functions in a timely fashion.

After proper notification, no Medicare or Medicaid claim will be paid if the service or item in question is subject to review by a PSRO, and has been disapproved by the PSRO.

The legislation specifically obligates each health care practitioner and provider, to the extent of their influence or control, to provide services:

- Only when and to the extent that they are medically necessary,

- Of a quality which meets professionally recognized standards of health care, and

- At the most economic level of service.

Failure to comply with these obligations, in a substantial number of cases, or one or more gross and flagrant violations of these obligations may lead to:

- Exclusion from eligibility for reimbursement under Medicare and Medicaid on a permanent basis, or for a stated period of time, or

- A requirement for repayment of the improper service or $5,000 whichever is less.

Both sanctions would be applied only after proper application of the appeals mechanism, described earlier, and exclusion from eligibility for payment would become effective only after notification to the public.

The provisions of this Amendment apply to the operation of any State plan approved under the Social Security Act as a Medicare or Medicaid health care program.

All data and information acquired by a PSRO is confidential and will only be disclosed on a need-to-know basis or as provided by the Secretary in regulations. Illegal disclosure may result in a fine of not more than $1,000 and imprisonment of not more than six months, or both.

Limitations on liability are provided by the legislation for activities in relation to a PSRO. Notwithstanding any other provision of law:

- No person will be liable for the provision of relevant information which he believes to be true, to a PSRO.

- In the absence of malice, no person is liable for the performance of his duties as an employee or agent of a PSRO.

- No practitioner or provider is liable for actions in his normal work, taken with due care, in compliance with the accepted norms of care and treatment applied by a PSRO in his area.

Implementation of the Program

The Secretary will establish appropriate areas for PSRO's, throughout the United States, not later than January 1, 1974 and designate qualified organizations as PSRO's at the earliest practicable date thereafter.

Pending assumption of responsibility, and demonstration of capacity for improved audit, current activities will be continued.

The Secretary will review and approve a formal plan for progressive assumption of full responsibility and initially designate an organization as a PSRO on a conditional basis. During the trial period (not to exceed 24 months) the Secretary may require the PSRO to perform only limited duties and functions. Assumption of responsibility for duties should proceed in accordance with the approved plan, so that at the end of the trial period, the PSRO is performing all required duties and functions.

Conditional PSRO agreements may be terminated by either party on 90 days' notice.

Any duties and functions not performed by a PSRO, during a trial period, will continue to be performed as presently authorized The Secretary is authorized to waive any other review requirements when substantial evidence indicates that the PSRO meets or exceeds those requirements.

The Secretary will provide regulations for correlation and cooperation between carriers, intermediaries, government agencies and PSRO's which include the usage of existing data gathering capacity where appropriate.

Exhibit 1

Length Of Stay For All The 778 Patients:

A Stem-And-Leaf Display

```
UNIT = 10**-1
 2 | C0000000C0
 3 | 00000000000000000000000000000000000
 4 | 000000000000000000000000000000000000000000000000000000
 5 | 0000000C000000000000000000000000000000000000000000000
 6 | 00000000000000000000000000000000000000000000000000
 7 | 0000000000000000000000000000000000
 8 | 000000000000000000000
 9 | 000000000000000000
10 | 0000000000
11 | 000000000

OUTLIERS: 12.    12.    12.    12.    12.    12.
          12.    13.    13.    13.    13.    13.
          13.    14.    14.    14.    15.    15.
          15.    16.    17.    17.    17.    17.
          17.    17.    18.    18.    18.    18.
          19.    20.    21.    29.    31.
          37.   119.
```

Exhibit 2

Correlation Matrix: Acute Appendicitis

	Secondary Diagnosis	Secondary Surgery	Age	Sex	Length of Stay
Secondary Diagnosis	1.000				
Secondary Surgery	0.4781	1.000			
Age	0.3028	0.1694	1.000		
Sex	0.0841	0.0592	0.0173	1.000	
Length of Stay	0.5092	0.3903	0.3224	0.0515	1.000

Exhibit 3a

Cross Tabulation Using Medians

Dependent Variable: Length of stay
Independent Variable: Secondary diagnosis

Level of Secondary Diagnosis	Median Length of Stay	Average Value of Absolute Deviations from the Median	Number of Observations in Each Cell
0	5.0 days	1.5	678
1	7.0 days	3.3	73
2	7.5 days	4.3	18
3	10.0 days	2.6	5
4	29.0 days	37.0	3
5	87.0 days	0.0	1

Exhibit 3b

Cross Tabulation Using Medians

Dependent Variable: Length of stay
Independent Variable: Secondary surgery

Level of Secondary Surgery	Median Length of Stay	Average Value of Absolute Deviations from the Median	Number of Observations in Each Cell
0	5.0 days	1.8	740
1	7.0 days	3.1	25
2	8.0 days	13.1	10
3	17.0 days	26.0	3

Exhibit 3c

Cross Tabulation Using Medians

Dependent Variable: Length of stay
Independent Variable: Sex

Sex	Median Length of Stay	Average Value of Absolute Deviations from the Median	Number of Observations in Each Cell
Male	5.0 days	1.8	414
Female	5.0 days	2.4	364

Exhibit 3d

Cross Tabulation Using Medians

Dependent Variable: Length of stay
Independent Variable: Age

Age Group	Median Length of Stay	Average Value of Absolute Deviations from the Median	Number of Observations in Each Cell
65 years or less	5.0 days	1.7	753
Greater than 65 years	12.0 days	12.0	25

Cross Tabulation Using Medians

Dependent Variable: Length of stay
Independent Variables: Secondary diagnosis
   & Secondary surgery

(a) Median Length of Stay:

Levels of Secondary Diagnosis \ Levels of Secondary Surgery	0	1	2	3
0	5.0 days	7.0 days	6.0 days	–
1	6.5 "	6.5 "	9.0 "	13.0 days
2	9.0 "	7.0 "	6.5 "	–
3	7.5 "	–	10.0 "	–
4	8.0 "	29.0 "	119.0 "	–
5	–	–	–	87.0 "

(b) Average value of absolute deviations from the median length of stay:

Levels of Secondary Diagnosis \ Levels of Secondary Surgery	0	1	2	3
0	1.5	1.2	0	–
1	3.4	2.9	2.4	4.0
2	5.3	0.7	0.5	–
3	3.3	–	0	–
4	0	0	0	–
5	–	–	–	0

(c) Number of observations in each cell:

Levels of Secondary Diagnosis \ Levels of Secondary Surgery	0	1	2	3
0	672	5	1	0
1	50	16	5	2
2	13	3	2	0
3	4	0	1	0
4	1	1	1	0
5	0	0	0	1

Cross Tabulation Using Medians

Dependent Variable: Length of stay
Independent Variables: Secondary Diagnosis,
Secondary Surgery,
and Age

(a) Median length of stay:

(i) When age is 65 years or less

Levels of Secondary Surgery \ Levels of Secondary Diagnosis	0	1	2	3	4	5
0	5.0	6.0	8.0	5.0	–	–
1	7.5	6.5	7.0	–	–	–
2	6.0	8.0	6.5	10.0	–	–
3	–	13.0	–	–	–	–

(ii) When age is greater than 65 years

Levels of Secondary Surgery \ Levels of Secondary Diagnosis	0	1	2	3	4	5
0	7.5	12.0	17.0	12.0	8.0	–
1	5.0	–	–	–	29.0	–
2	–	12.0	–	–	119.0	–
3	–	–	–	–	–	87.0

(b) Average value of absolute deviations from the median length of stay:

(i) When age is 65 years or less

Levels of Secondary Surgery \ Levels of Secondary Diagnosis	0	1	2	3	4	5
0	1.5	2.6	5.2	2.0	–	–
1	1.0	2.9	0.7	–	–	–
2	0	2.3	0.5	0	–	–
3	–	4.0	–	–	–	–

(ii) When age is greater than 65 years

Levels of Secondary Surgery \ Levels of Secondary Diagnosis	0	1	2	3	4	5
0	3.4	5.2	3.0	0	0	–
1	0	–	–	–	0	–
2	–	0	–	–	0	–
3	–	–	–	–	–	0

(c) Number of observations in each cell:

(i) When age is 65 years or less

Levels of Secondary Surgery \ Levels of Secondary Diagnosis	0	1	2	3	4	5
0	662	45	10	3	0	0
1	4	16	3	0	0	0
2	1	4	2	1	0	0
3	0	2	0	0	0	0

(ii) When age is greater than 65 years

Levels of Secondary Surgery \ Levels of Secondary Diagnosis	0	1	2	3	4	5
0	10	5	3	1	1	0
1	1	0	0	0	1	0
2	0	1	0	0	1	0
3	0	0	0	0	0	1

Exhibit 4

PLOT OF MEAN LENGTH OF STAY OVER TIM[E]

$X_2 = 0$

$X_3 = 0$

$X_7 \leq 65$ Years

MEAN LENGTH OF STAY →

← MEAN LENGTH OF STAY →

←1. =T
←2. =T
←3. =T
←4. =T
←5. =T
←6. =T
←7. =T
←8. =T
←9. =T
←10. =T
←11. =T
←12. =T
←13. =T
←14. =T
←15. =T
←16. =T
←17. =T
←18. =T
←19. =T
←20. =T
←21. =T
←22. =T
←23. =T
←24. =T
←25. =T
←26. =T
←27. =T
←28. =T
←29. =T
←30. =T
←31. =T
←32. =T
←33. =T
←34. =T
←35. =T

Date of passage
of the Bennet Amendment
OCTOBER 30, 1972

Date of Introduction
of the Actual Audit
APRIL, 1975

← TIME IN QUARTERS →
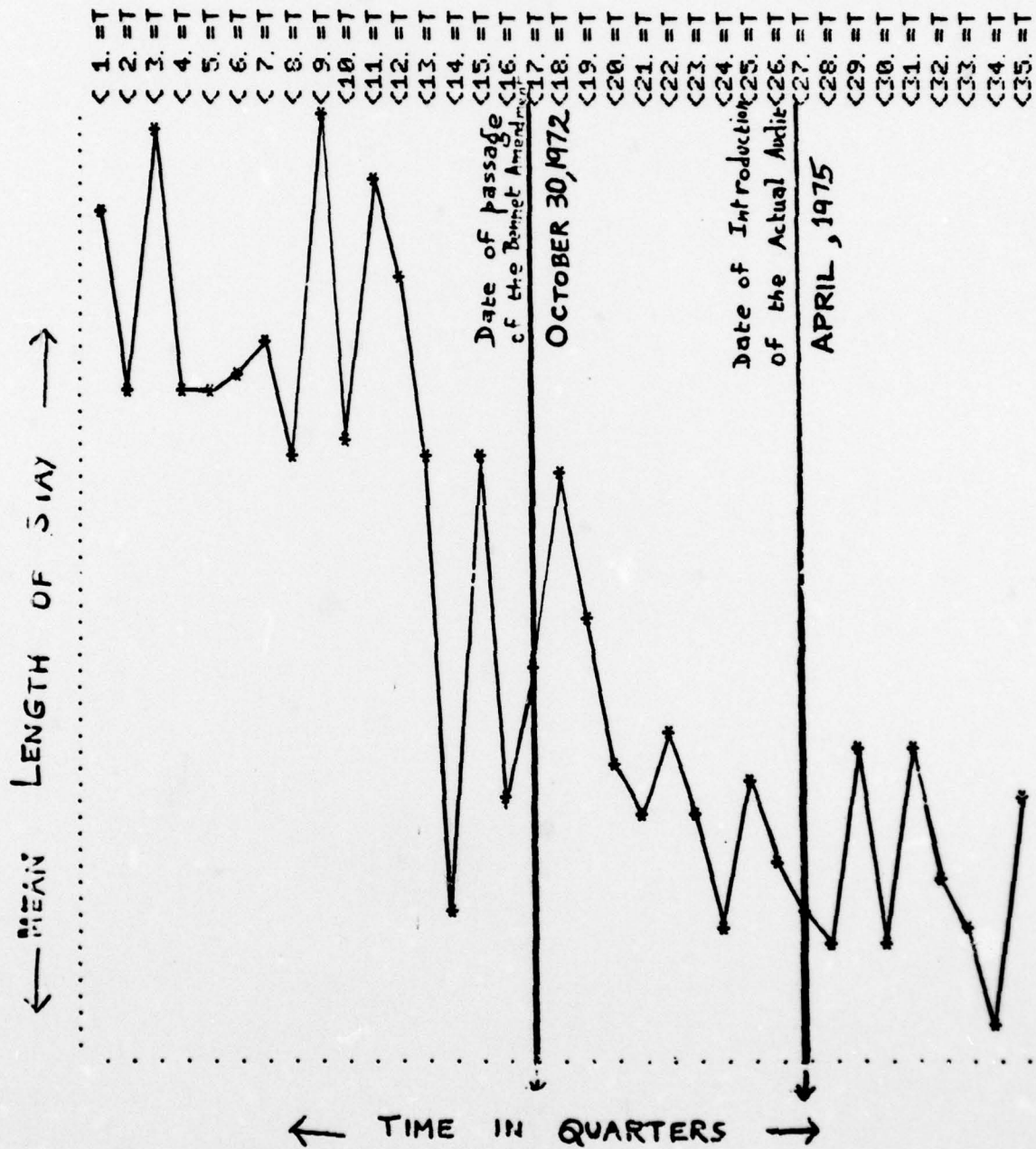
Length Of Stay During No Audit:

A Stem-And-Leaf Display

```
(UNIT = 10**-1)
 2. : 000
 2. :
 3. : 00000000
 3. :
 4. : 0000000000000000000000000000000000000000
 4. :
 5. : 00000000000000000000000000000000000000000000000000000000000000
 5. :
 6. : 000000000000000000000000000000000000000000
 6. : 00000000000000000
 7. : 0000000000000000000000000000000000000
 7. : 000000000000000000000000000000000
 8. : 0000000000000000000000000000000000000000
 8. :
 9. : 00000000000000000000000000000000
 9. :
10. : 0000
10. :
11. : 0000
11. :
12. : 0

OUTLIERS :   13.      13.      14.      15.      13.
```

Exhibit 5b

Length Of Stay During Audit Anticipation:

A Stem-And-Leaf Display

```
(UNIT = 10**-1)
2 : 0000
2. :
3. : 0000000000000000
3. :
4 : 000000000000000000000000000000000000000000000000000
4. : 000000000000000000000000000000000000000000
5. : 000000000000000000000000000000000000000000000000
5. :
6. : 0000000000000000000000000000
6. :
7. : 00000000000000000
7. :
8. : 000000
8. :
9. : 00000
```

OUTLIERS : 10.   12.   12.   13.   17.   17.

Length of Stay During Actual Audit: A Stem-and-Leaf Display
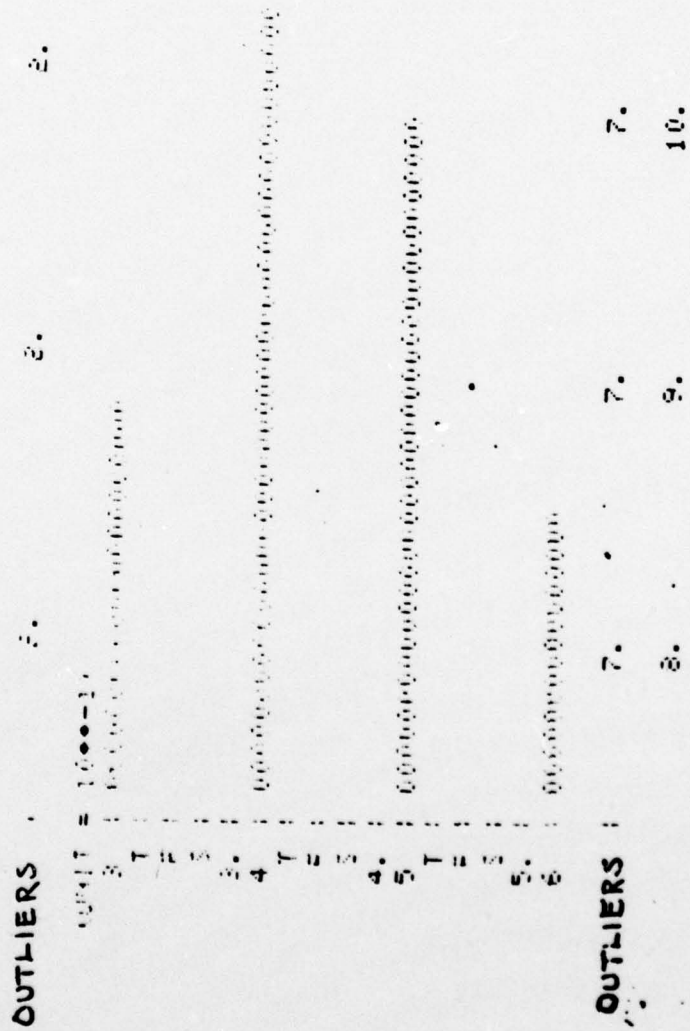
Exhibit 6

SCHEMATIC PLOT OF LENGTH OF STAY

20.0

15.0

10.0

5.0

0.0

NOAUDIT

AUDITANT-
-ICIPATION

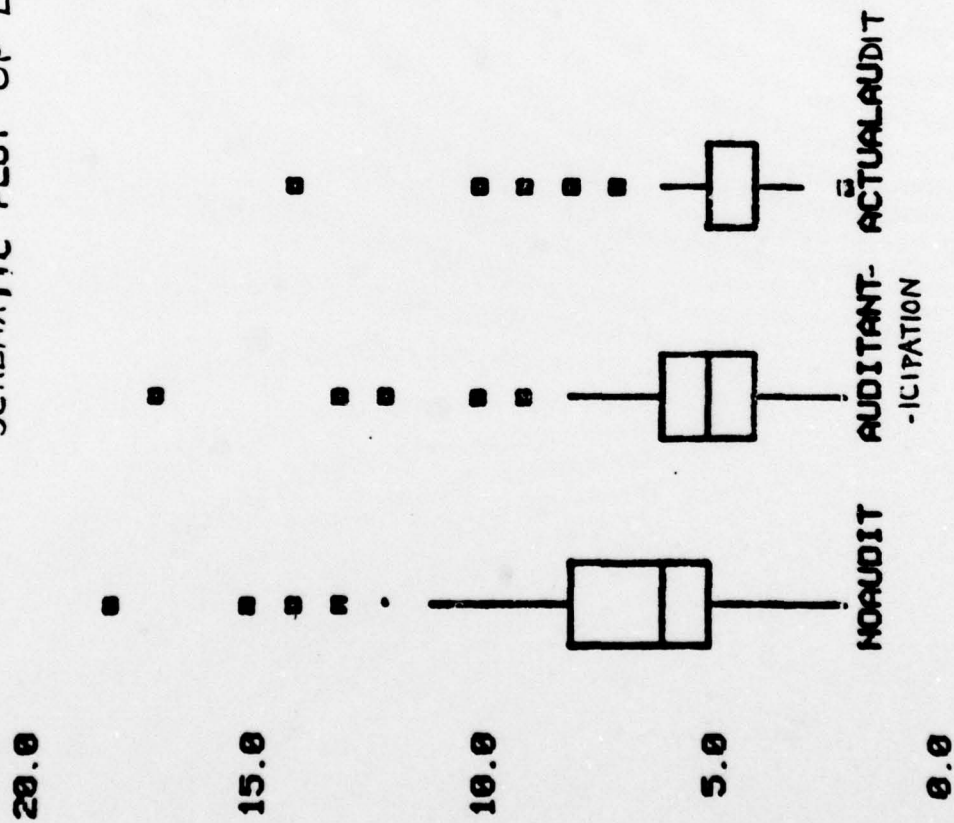AUDITANT-
ACTUALAUDIT

Exhibit 7

BOX PLOT

Exhibit 7

Exhibit 8

Analysis by Surgeons for Primary Cholecystectomy

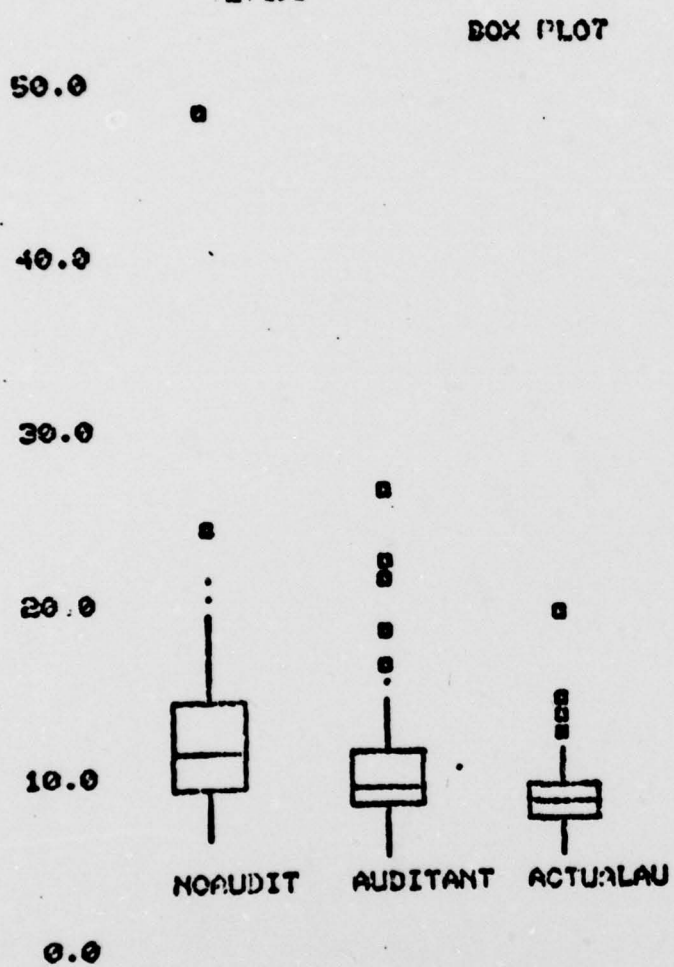| Surgeon Code No.	Number of Uncomplicated Cases Treated 1968-1977	Year of Graduation From Medical School	Month and Year in Which Hospital Privilege Granted	Age of the Surgeon (as of 12/77)
1	38	1935	May 1946	70 years
2	27	1949	Sept. 1958	52
3	23	1945	May 1951	54
4	21	1930	1935	72
5	22	1944	April 1950	61
6	86	1956	July 1965	46
7	23	1958	July 1963	47
8	34	1962	March 1967	42
9	22	1961	October 1969	43

Exhibit 9

Analysis by Surgeons for Acute Appendicitis

Surgeon Code No.	Number of Uncomplicated Cases Treated 1968-1977	Year of Graduation From Medical School	Month and Year in Which Hospital Privilege Granted	Age of the Surgeon (as of 12/77)
10	65	1950	April 1957	54 years
11	32	1948	May 1955	55
2	20	1949	Sept. 1958	52
3	41	1945	May 1951	54
4	31	1930	1935	72
12	55	1944	June 1955	58
6	80	1956	July 1965	46
13	66	1958	Nov. 1963	45
8	56	1962	March 1967	42
9	62	1961	Oct. 1969	43

Exhibit 10

Analysis by Surgeon: Primary Cholecystectomy

Surgeon Code No.	Time Period	Number of Patients Treated	Median Length of Stay	Average Value of Absolute Deviation From the Median
1	No Audit	22	11 days	1.95
	Audit Anticipation	9	9	1.44
	Actual Audit	7	9	0.71
2	No Audit	12	12	2.83
	Audit Anticipation	11	9	1.27
	Actual Audit	4	8	1.75
3	No Audit	12	9	2.08
	Audit Anticipation	5	9	0.40
	Actual Audit	6	8	1.17
4	No Audit	18	10	2.39
	Audit Anticipation	3	11	3.00
	Actual Audit	-	-	-
5	No Audit	10	13	1.70
	Audit Anticipation	4	7.5	2.00
	Actual Audit	8	9.5	2.00
6	No Audit	36	9	2.28
	Audit Anticipation	26	8	2.08
	Actual Audit	24	7	1.21
7	No Audit	5	9	2.20
	Audit Anticipation	13	9	2.31
	Actual Audit	5	9	3.40
8	No Audit	8	13	3.12
	Audit Anticipation	10	9	1.60
	Actual Audit	16	8	1.25
9	No Audit	3	11	2.67
	Audit Anticipation	7	9	1.14
	Actual Audit	12	8	0.67

Exhibit 11

Analysis by Doctors: Acute Appendicitis

Doctors' Code No.	Time Period	Number of Patients Treated	Median Length of Stay	Avg. Value of Absolute Deviations from the Median
10	No Audit	33	6.00 days	1.64
	Audit Anticipation	18	5.00 "	0.72
	Actual Audit	14	6.00 "	1.21
11	No Audit	12	7.00 days	0.92
	Audit Anticipation	11	5.00 "	1.55
	Actual Audit	9	5.00 "	0.56
2	No Audit	7	6.00 days	0.71
	Audit Anticipation	12	5.00 "	0.58
	Actual Audit	1	5.00 "	–
3	No Audit	22	5.00 days	0.68
	Audit Anticipation	10	5.00 "	0.50
	Actual Audit	9	4.00 "	0.56
4	No Audit	20	7.00 days	1.20
	Audit Anticipation	11	7.00 "	3.00
	Actual Audit	0	0	0
12	No Audit	27	7.00 days	1.63
	Audit Anticipation	14	6.00 "	1.00
	Actual Audit	14	5.50 "	0.64
6	No Audit	34	6.00 days	2.09
	Audit Anticipation	26	4.00 "	0.77
	Actual Audit	20	3.50 "	0.85
13	No Audit	24	5.00 days	0.96
	Audit Anticipation	28	5.00 "	0.86
	Actual Audit	14	4.00 "	0.50
8	No Audit	31	6.00 days	1.52
	Audit Anticipation	11	6.00 "	1.18
	Actual Audit	14	4.00 "	0.43
9	No Audit	12	5.50 days	1.00
	Audit Anticipation	35	4.00 "	0.50
	Actual Audit	15	4.00 "	0.67

References

Campbell, D. T. and Stanley, J. C., Experimental and Quasi-Experimental Designs for Research (Chicago: Rand-McNally College Publishing Company, 1962).

Churchill, N.C., "Behavioral Effects on An Audit: An Experimental Study," (Ph.D. Dissertation, University of Michigan, 1962).

Churchill, N.C., Cooper, W. W., Govindarajan, V., Pond, J. D., and San Miguel, J. G., "Developments in Comprehensive Auditing and Suggestions for Research," Proccedings of a Conference on Research in Auditing (University of Illinois, Urbana, 1977).

Cooper, W. W., and Ijiri, Y., "Accounting and Accountability Relations," in W. W. Cooper and Y. Ijiri (ed), Eric Louis Kohler -- Accounting's Man of Principles (Reston Publishing Co., forthcoming).

Govindarajan, V., "Behavioral Effects of Audits in the Delivery of Health Care Services -- A Study in the Field Using Exploratory Data Analysis and Classical Statistical Techniques," (unpublished Doctoral Dissertation, Harvard University Graduate School of Business Administration, 1978).

Govindarajan, V., and Pond, J.D., "Evaluation of Social Programs: Some Thoughts on the Role of Accountants," The Accounting Journal, Vol. 1, No. 2 (1978).

Lave, J. R., and Leinhardt, S., "An Evaluation of a Hospital Stay Regulatory Mechanis," American Journal of Public Health, Vol. 66, No. 10 (1976).

Tukey, J. W., Exploratory Data Analysis (Addison-Wesley, 1977).